



## General

### Guideline Title

ACR Appropriateness Criteria® claudication — suspected vascular etiology.

### Bibliographic Source(s)

Dill KE, Rybicki FJ, Desjardins B, Flamm SD, Francois CJ, Gerhard-Herman MD, Kalva SP, Mansour MA, Mohler ER III, Oliva IB, Schenker MP, Weiss C, Expert Panel on Vascular Imaging. ACR Appropriateness Criteria® claudication -- suspected vascular etiology. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 7 p. [65 references]

### Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Rybicki FJ, Buckley O, Yucel EK, Baum RA, Desjardins B, Flamm SD, Foley WD, Jaff MR, Koss SA, Mammen L, Mansour A, Narra VR, Expert Panel on Vascular Imaging. ACR Appropriateness Criteria® claudication -- suspected vascular etiology. [online publication]. Reston (VA): American College of Radiology (ACR); 2009. 7 p. [57 references]

## Recommendations

### Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Claudication — Suspected Vascular Etiology

Radiologic Procedure	Rating	Comments	RRL*
Segmental Doppler pressures and pulse volume recordings	9	Appropriate for screening patients with symptoms and findings suggestive of peripheral vascular disease. Compressibility artifact limits interpretation of pressures, but pulse volume recordings remain interpretable in this setting.	O
MRA lower extremity without and with contrast	8	See statement regarding contrast in text under "Anticipated Exceptions."	O
CTA lower extremity with contrast	8	Test of choice in patients that cannot have MRA.	⊕⊕⊕⊕
US lower extremity with Doppler	7	Useful in patients with contrast allergy or renal dysfunction.	O
Arteriography lower extremity	7	Indicated only if intervention is planned.	⊕⊕⊕⊕

Radiologic Procedure	Rating	Comments	RRL*
MRA lower extremity without contrast	5	Appropriate in patients with contraindications to iodinated and gadolinium-based contrast agents.	Q
<b>Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate</b>			<b>*Relative Radiation Level</b>

Note: Abbreviations used in the table are listed at the end of the "Major Recommendations" field.

## Summary of Literature Review

### Introduction/Background

Claudication is a symptom complex characterized by pain and weakness in an active muscle group, reproducibly precipitated by similar amounts of exercise and promptly relieved by rest. Claudication is the most common manifestation of peripheral arterial disease (PAD), but other disease entities can cause a similar clinical picture. Nonarterial etiologies represent 20% to 38% of patients being evaluated for claudication. The most common nonarterial cause is neurogenic disease (especially spinal stenosis), but other diseases such as compartment syndromes, pelvic tumors, and chronic venous occlusion have also been associated with symptoms similar to claudication. In addition, most patients with peripheral arterial occlusive disease are asymptomatic; as few as 6% to 20% of such patients will have symptoms of claudication.

Estimates of the prevalence of claudication in the general population range from less than 1% to almost 8%, depending on the age, gender, the geographic location of the population, and the diagnostic criteria used. The presence of vascular disease in patients with symptoms of claudication is reliably established by a variety of noninvasive hemodynamic tests. In patients who do not have demonstrable arterial disease, imaging studies of other systems such as the lumbar spine or soft-tissues of the pelvis may be indicated. If peripheral vascular disease is confirmed, additional studies may be indicated to screen the heart and carotid arteries.

The presence and severity of arterial obstructions are reliably established using noninvasive hemodynamic tests such as the ankle brachial index (ABI), toe brachial index (TBI), segmental pressures, or pulse volume recordings (PVRs). Infrared thermography shows promise as an additional noninvasive examination. Vascular imaging is used for diagnosing individual lesions and to triage patients into medical versus percutaneous therapy versus surgical intervention. The indications for surgical or percutaneous intervention are controversial, and thus specific indications for imaging studies remain ill defined. Factors that influence this decision include: 1) the natural history of limb and patient survival, 2) the patient's tolerance of symptoms and resulting changes in lifestyle, 3) the effectiveness of medical or exercise therapy, 4) the potential risks of invasive tests and treatments, and 5) the short-term and long-term outcomes of surgery or interventional procedures.

Based on natural history studies, the risk of amputation in patients suffering from claudication is approximately 1% per year. Since most of these studies were performed before the era of noninvasive testing, many patients who did not actually have vascular disease were probably included, which may have caused the frequency of serious complications to be underestimated. Modern natural history studies, using noninvasive hemodynamic tests to confirm the presence of vascular disease, show that progression of symptoms occurs in 25% to 60% of surviving patients within 5 years of presentation. Because the risks associated with interventional procedures are low compared with surgery, image-guided interventional studies may be indicated for less severe disease.

### Noninvasive Hemodynamic Studies

In combination with the history and physical examination of patients, noninvasive hemodynamic studies have become an important tool for evaluating peripheral vascular disease. Their importance is related to their ability to provide an objective test for the presence or absence of peripheral vascular disease. They also provide a valuable means of quantifying the severity of vascular disease and are useful in documenting the functional significance of arterial lesions demonstrated by angiography.

There is no consensus regarding which test is most valuable or accurate, because there may be considerable variability depending on clinical circumstances. For instance, patients with stiff, noncompliant arteries (often associated with diabetes) are difficult to study using tests such as the ABI or segmental pressures that depend on measurements of arterial pressure. In these patients the TBI or PVR may be more helpful. Most laboratories use a combination of tests that increases overall sensitivity and accuracy. The simplicity, reliability, and noninvasive nature of these tests have led to their routine use in screening patients with appropriate symptoms and physical findings. The presence of a normal ABI both at rest and following exercise in a patient with compressible vessels effectively excludes atherosclerotic occlusive disease as a cause of leg claudication and obviates the need for additional arterial imaging. However, the ABI will not evaluate for hypogastric arterial occlusions that may produce buttock claudication. The main limitation of noninvasive testing is that proving the presence of vascular disease does not necessarily exclude the possibility that symptoms are nonetheless caused by neurologic disease. Careful correlation with clinical evaluation is necessary and, in certain cases, tests to rule out neurologic disease (e.g., spine or pelvic magnetic resonance imaging [MRI]) may be indicated.

## Contrast Angiography

Once the decision has been made that treatment of a lesion will improve quality of life, accurate assessment of the peripheral arteries is essential for adequate planning of the procedure. Digital subtraction angiography (DSA) remains the reference standard for imaging the peripheral arteries. Multiple projections, including oblique views, are usually necessary for a complete study because of the overlapping of branching vessels, the anteroposterior course of the pelvic vessels, and the tendency of atherosclerotic plaque to develop on the posterior arterial wall. The development of digital subtraction has enhanced the ability of contrast angiography to visualize vessels that are poorly opacified and permits multiple views while minimizing the amount of contrast injected. Endovascular treatment of peripheral vascular disease including stenting, embolization, and arthroectomy is increasingly being used. DSA provides dynamic and accurate depiction of the peripheral vascular system.

The presence of diffusely diseased arteries can present challenges during angiography, as stenosis severity can be difficult to determine in the absence of normal arterial segments for comparison. In addition, serial lesions, luminal irregularity, and the degree of collateral development may produce effects on the blood flow that are difficult to quantify angiographically.

The main drawbacks of DSA in patients with claudication that has a suspected vascular etiology are its invasive nature and the known complications from catheterization. These difficulties can be averted, however, by using noninvasive methods to accurately triage patients with confirmed PAD to percutaneous or surgical treatments. For the latter, preoperative DSA may not be needed.

Finally, DSA has inconsistent correlation between the hemodynamic or functional effects and the morphology of the arterial lesions. Several studies have reported this problem, but in some of them the problem may be accentuated by less than optimal angiographic technique (e.g., single projection, nonselective injections).

## Noninvasive Imaging

### *Duplex Ultrasound*

Duplex ultrasound (US) of the extremities can be used to diagnose the location, degree, and extent of stenosis to the level of the knee. Although duplex US includes images, in either black and white or color format, the primary clinically relevant information derived from duplex studies has been validated from analysis of the velocity of blood flow.

The sensitivity and specificity for the diagnosis of stenoses >50% in diameter from the iliac arteries to the popliteal arteries are each approximately 90% to 95%. Accuracy of the duplex examination depends on the ability of the technique to visualize the vessel adequately. The use of color improves accuracy. Accuracy is diminished in examinations of the iliac arteries if bowel gas or tortuosity obscures the iliac vessels. Dense calcification can also obscure flow, particularly if flow is slow. Accuracy of duplex US is also decreased in the setting of multiple sequential lesions.

Duplex US can be used for choosing between endovascular and surgical revascularization, although it is not satisfactory for evaluating tibial arteries for distal bypass. Duplex US following angioplasty is widely performed to detect recurrent stenoses but has not yet been demonstrated to improve patient outcomes. Duplex US is used in specialist centers for preoperative arterial mapping, but in many centers the diagnostic confidence is low with this technique and additional studies are often ordered. This renders duplex arterial preoperative mapping a less cost effective option as further studies are often ordered. The examination requires a highly skilled sonographer and can require over an hour to perform.

### *Magnetic Resonance Angiography*

Magnetic resonance angiography (MRA) techniques continue to evolve and improve, including the more recent use of noncontrast-only imaging in patients with renal insufficiency. Two-dimensional time of flight, three-dimensional imaging, contrast enhancement with gadolinium, subtraction, cardiac gating, bolus chase, parallel imaging, optimized K-space filling, 3T magnet strength, and improved coil technology have led to improved temporal resolution, spatial resolution, and signal to noise in MRA. Its sensitivity and specificity for detection of stenoses >50% are now in the 90% to 100% range, which is much better than catheter angiography provides. As a result, MRA is now a first-line technique in many centers for the imaging of peripheral vascular disease. Dedicated time resolved imaging of the calves and pedal arteries provides accurate identification of infrageniculate arteries and pedal arteries as potential touch-down sites for bypass surgeries.

The majority of magnetic resonance (MR) approaches use noncontrast sequences followed by the intravenous administration of a gadolinium-based agent. In comparison to color duplex US, contrast-enhanced MRA is more accurate for detecting significant stenoses and for preoperative planning. Both MRA and computed tomography angiography (CTA) are more cost-effective than duplex US, and MRA is more cost-effective and safer than DSA. For postoperative and postangioplasty surveillance, small studies have shown MRA to be helpful in detecting recurrent disease, but improved outcomes for such surveillance have not been documented. Regarding comparative studies, MRA typically has not supplanted DSA as a reference standard. However, technology, experience, and protocol optimization have enhanced the use of contrast-enhanced MRA as a replacement for DSA in the initial evaluation. These improvements include 3-Tesla field strength, whole-body angiography, reduced gadolinium doses, and contrast agents with improved relaxivity and vascular retention characteristics.

Recent advancements in noncontrast MRA techniques for imaging peripheral artery disease have expanded the sequence options from time-of-flight and phase-contrast imaging to include electrocardiography (ECG)-gated fresh blood partial Fourier fast spin echo, balanced steady-state free precession, and spin labeling. Two alternative approaches using balanced steady state for peripheral MRA applications include flow-sensitive dephasing and quiescent-interval single shot. When compared to bolus-chase and time-resolved gadolinium-enhanced MRA, initial studies of fresh blood imaging of the calf and pedal arteries have provided accurate imaging when technically successful. Overall, these methods are being increasingly adopted for patients with renal insufficiency.

Some technical problems limit the utility of MRA for imaging peripheral vascular disease. Challenges may include image quality related to low signal/noise ratio, limited spatial resolution, motion artifacts, long acquisition times, unreliable visualization of lesions with high flow and turbulence (excessive signal loss at regions of high-grade stenoses), nonvisualization of patent vessel segments with reversed blood flow, the need to exclude patients with pacemakers or other metallic implants, and loss of signal in arterial segments within metal stents or adjacent to metallic clips or prosthetic joints. Some of these problems have been addressed successfully with the use of newer imaging sequences and the addition of MR contrast agents. With the newer noncontrast techniques, cardiac arrhythmia can impair image quality, limiting evaluation of the distal calf and pedal arteries. Although useful tools to improve image quality have been suggested, larger-scale trials are required for evaluation of small-vessel peripheral artery disease with noncontrast MRA.

MRA has not yet replaced catheter angiography as the gold standard in comparative studies, but it has largely replaced angiography in some institutions for preintervention planning. This is due to improvements in imaging sequences as well as experience among radiologists. In addition, contrast agents are considered safe in patients with normal renal function. In these patients, MRA is likely to entirely supplant catheter angiography as a pure diagnostic tool.

### *Computed Tomography Angiography (CTA)*

Spiral or helical CTA is increasingly used for imaging peripheral vascular disease. Multidetector CT scanners, including helical and multistation axial acquisitions, enable rapid scanning of the entire arterial system. When compared to DSA, CTA offers volumetric as opposed to planar images and generally requires less radiation exposure with comparable or lower iodine loads. The volumetric acquisition enables extensive image postprocessing including multi-planar reformatted and maximum-intensity projection images to create an arterial road map; lower radiation and iodine doses have a favorable safety profile. With optimized timing of the acquisition, CT images include collaterals and arteries distal to occlusions that may not appear on DSA images. Like MRA, CTA has good soft-tissue contrast and thus shows nonvascular findings as well as vascular lesions associated with aneurysms and cystic adventitial disease that are not detected with the lumen imaging inherent to DSA.

While it has been suggested that CT alone can be used to plan treatment, including interventions that require morphological assessment of the lesions including the length, severity and number of stenoses, its spatial resolution is inferior to that of DSA. Compared to catheter angiography, the sensitivity and specificity of 4-, 16- and 64-detector row CTA for detection of stenoses >50% diameter are 90% to 100%. Accuracy in patients with bypass grafts is excellent compared to duplex US. CTA is also clinically more useful and cost-effective than duplex US. However, heavily calcified atheromatous disease limits the ability to interpret CT images. This drawback is usually related to calf arteries; identification of patients who are unsuitable candidates for CTA (e.g., >84 years of age, diabetic, on dialysis, with heart disease) will reduce the number of insensitive studies. Another limitation of CTA that is typically seen in the calf arteries is related to the timing of the acquisition with respect to the iodine bolus. Images acquired too late will have problematic venous contamination. More common with newer CT technologies is imaging too early for either one leg with slow flow from outflow disease or for both legs secondary to the very fast scanning protocols. In general, these pitfalls are less problematic in MRI since time-resolved imaging could be used with modern technologies to improve the MR properties of image quality.

Compared to MRI, CT has the advantages of more rapid acquisition, better safety in patients with pacemakers or defibrillators, and generally less severe artifact from metal. Finally, claustrophobia is far less of a problem.

### *Summary*

- The purpose of vascular imaging studies is to define the location and extent of vascular lesions and to triage patients into percutaneous or surgical interventions.
- The clinical success of these vascular procedures depends largely on accurate, complete visualization of the entire lower extremity arterial system, or at least of the entire symptomatic extremity and the pelvic vasculature.
- Several noninvasive vascular imaging methods have proven useful for a growing cohort of patients who present with claudication and a suspected vascular etiology. All, however, currently have important practical limitations.
- Although the role of these techniques in evaluating patients with peripheral vascular disease continues to evolve, digital subtraction angiography remains the reference standard, particularly when intervention is anticipated.
- The noninvasive imaging modalities, supplemented by physical examination and history, usually provide all the information needed to confirm or exclude the presence of peripheral vascular disease as the cause of claudication. Further, they can provide sufficient information to

accurately plan medical, surgical, or catheter-directed treatment.

- The choice of noninvasive imaging modality will depend on local expertise and experience.

#### Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e.,  $<30$  mL/min/1.73 m<sup>2</sup>), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates  $<30$  mL/min/1.73 m<sup>2</sup>. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

#### Abbreviations

- CTA, computed tomography angiography
- MRA, magnetic resonance angiography
- US, ultrasound

#### Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☢	$<0.1$ mSv	$<0.03$ mSv
☢ ☢	0.1-1 mSv	0.03-0.3 mSv
☢ ☢ ☢	1-10 mSv	0.3-3 mSv
☢ ☢ ☢ ☢	10-30 mSv	3-10 mSv
☢ ☢ ☢ ☢ ☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

## Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

## Scope

### Disease/Condition(s)

Claudication of suspected vascular etiology

### Guideline Category

Diagnosis

Evaluation

### Clinical Specialty

Cardiology

Family Practice

Internal Medicine

Radiology

## Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physicians

Utilization Management

## Guideline Objective(s)

To evaluate the appropriateness of initial radiologic examinations for patients with claudication of suspected vascular etiology

## Target Population

Patients with claudication of suspected vascular etiology

## Interventions and Practices Considered

1. Segmental Doppler pressures and pulse volume recordings
2. Magnetic resonance angiography (MRA)
  - Lower extremity without and with contrast
  - Lower extremity without contrast
3. Computed tomography angiography (CTA) lower extremity with contrast
4. Ultrasound (US) lower extremity with Doppler
5. Arteriography lower extremity

## Major Outcomes Considered

Utility of radiologic examinations in differential diagnosis

## Methodology

### Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

### Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 5 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

## Number of Source Documents

The total number of source documents identified as the result of the literature search is not known.

## Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

### Rating Scheme for the Strength of the Evidence

Strength of Evidence Key

Category 1 - The conclusions of the study are valid and strongly supported by study design, analysis, and results.

Category 2 - The conclusions of the study are likely valid, but study design does not permit certainty.

Category 3 - The conclusions of the study may be valid, but the evidence supporting the conclusions is inconclusive or equivocal.

Category 4 - The conclusions of the study may not be valid because the evidence may not be reliable given the study design or analysis.

## Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

### Description of the Methods Used to Analyze the Evidence

The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence for all articles included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member forms his/her own opinion based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

## Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

### Description of Methods Used to Formulate the Recommendations

Modified Delphi Technique

The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distributes surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The ratings are a scale between 1 and 9, which is further divided into three categories: 1, 2, or 3 is defined as "usually not appropriate"; 4, 5, or 6 is defined as "may be appropriate"; and 7, 8, or 9 is defined as "usually appropriate." Each panel member assigns one rating for each procedure per survey round. The surveys are collected and the results are tabulated, de-identified and redistributed after each round. A maximum of three rounds are conducted. The modified Delphi technique enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive bias from fellow panelists in a simple, standardized and economical process.

Consensus among the panel members must be achieved to determine the final rating for each procedure. Consensus is defined as eighty percent (80%) agreement within a rating category. The final rating is determined by the median of all the ratings once consensus has been reached. Up to three rating rounds are conducted to achieve consensus.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is accepted as the panel's consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is circulated, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

### Rating Scheme for the Strength of the Recommendations

Not applicable

### Cost Analysis

- In many specialist centers the diagnostic confidence of duplex ultrasound (US) is low, and additional studies are often ordered. This renders duplex arterial preoperative mapping a less cost-effective option.
- Both magnetic resonance angiography (MRA) and computed tomography angiography (CTA) are more cost-effective than duplex US. MRA is more cost effective and safer than digital subtraction angiography (DSA).
- It has been shown that CTA is more clinically useful and cost-effective than duplex US.

### Method of Guideline Validation

Internal Peer Review

### Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

## Evidence Supporting the Recommendations

### Type of Evidence Supporting the Recommendations



The recommendations are based on analysis of the current literature and expert panel consensus.

## Benefits/Harms of Implementing the Guideline Recommendations

### Potential Benefits

Selection of appropriate radiologic imaging procedures for evaluation of patients with claudication

### Potential Harms

- The main limitation of noninvasive testing is that proving the presence of vascular disease does not necessarily exclude the possibility that symptoms are nonetheless caused by neurologic disease.
- The main drawbacks of digital subtraction angiography (DSA) in patients with claudication that has a suspected vascular etiology are its invasive nature and the known complications from catheterization.
- DSA has inconsistent correlation between the hemodynamic or functional effects and the morphology of the arterial lesions. Several studies have reported this problem, but in some of them the problem may be accentuated by less than optimal angiographic technique (e.g., single projection, nonselective injections).
- Some technical problems limit the utility of magnetic resonance angiography (MRA) for imaging peripheral vascular disease. Challenges may include image quality related to low signal/noise ratio, limited spatial resolution, motion artifacts, long acquisition times, unreliable visualization of lesions with high flow and turbulence (excessive signal loss at regions of high-grade stenoses), nonvisualization of patent vessel segments with reversed blood flow, the need to exclude patients with pacemakers or other metallic implants, and loss of signal in arterial segments within metal stents or adjacent to metallic clips or prosthetic joints. With the newer noncontrast techniques, cardiac arrhythmia can impair image quality, limiting evaluation of the distal calf and pedal arteries.
- Heavily calcified atheromatous disease limits the ability to interpret computed tomography (CT) images. This drawback is usually related to calf arteries. Another limitation of computed tomography angiography (CTA) that is typically seen in the calf arteries is related to the timing of the acquisition with respect to the iodine bolus. Images acquired too late will have problematic venous contamination. More common with newer CT technologies is imaging too early for either one leg with slow flow from outflow disease or for both legs secondary to the very fast scanning protocols.

### Gadolinium-based Contrast Agents

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e.,  $<30$  mL/min/1.73 m<sup>2</sup>), and almost never in other patients. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates  $<30$  mL/min/1.73 m<sup>2</sup>. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

### Relative Radiation Level (RRL)

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, an RRL indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (see the "Availability of Companion Documents" field).

## Qualifying Statements

## Qualifying Statements

The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists, and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

## Implementation of the Guideline

### Description of Implementation Strategy

An implementation strategy was not provided.

## Institute of Medicine (IOM) National Healthcare Quality Report Categories

### IOM Care Need

Getting Better

### IOM Domain

Effectiveness

## Identifying Information and Availability

### Bibliographic Source(s)

Dill KE, Rybicki FJ, Desjardins B, Flamm SD, Francois CJ, Gerhard-Herman MD, Kalva SP, Mansour MA, Mohler ER III, Oliva IB, Schenker MP, Weiss C, Expert Panel on Vascular Imaging. ACR Appropriateness Criteria® claudication -- suspected vascular etiology. [online publication]. Reston (VA): American College of Radiology (ACR); 2012. 7 p. [65 references]

### Adaptation

Not applicable: The guideline was not adapted from another source.

### Date Released

1995 (revised 2012)

## Guideline Developer(s)

American College of Radiology - Medical Specialty Society

## Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

## Guideline Committee

Committee on Appropriateness Criteria, Expert Panel on Vascular Imaging

## Composition of Group That Authored the Guideline

*Panel Members:* Karin E. Dill, MD (*Principal Author and Panel Vice-Chair*); Frank J. Rybicki, MD, PhD (*Panel Chair*); Benoit Desjardins, MD, PhD; Scott D. Flamm, MD; Christopher J. Francois, MD; Marie D. Gerhard-Herman, MD; Sanjeeva P. Kalva, MD; M. Ashraf Mansour, MD; Emile R. Mohler III, MD; Isabel B. Oliva, MD; Matthew P. Schenker, MD; Clifford Weiss, MD

## Financial Disclosures/Conflicts of Interest

Not stated

## Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Rybicki FJ, Buckley O, Yucel EK, Baum RA, Desjardins B, Flamm SD, Foley WD, Jaff MR, Koss SA, Mammen L, Mansour A, Narra VR, Expert Panel on Vascular Imaging. ACR Appropriateness Criteria® claudication -- suspected vascular etiology. [online publication]. Reston (VA): American College of Radiology (ACR); 2009. 7 p. [57 references]

## Guideline Availability

Electronic copies: Available from the [American College of Radiology \(ACR\) Web site](#) .

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

## Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the [American College of Radiology \(ACR\) Web site](#) .
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in Portable Document Format (PDF) from the [ACR Web site](#) .
- ACR Appropriateness Criteria®. Evidence table development – diagnostic studies. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available in PDF from the [ACR Web site](#) .
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the [ACR Web site](#) .
- ACR Appropriateness Criteria® Manual on contrast media. Reston (VA): American College of Radiology; 90 p. Electronic copies: Available in PDF from the [ACR Web site](#) .
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available in

PDF from the [ACR Web site](#) .

- ACR Appropriateness Criteria® claudication-suspected vascular etiology. Evidence table. Reston (VA): American College of Radiology; 2012. 26 p. Electronic copies: Available from the [ACR Web site](#) .

## Patient Resources

None available

## NGC Status

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